



MODEL PLANNING AND CONTROLLING SYSTEM FOR EPC OF INDUSTRIAL PROJECTS

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for EPC of
Industrial Projects**

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The Construction Industry Institute
Cost/Schedule Controls Task Force**

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INTRODUCTION

An industrial facility is built by an owner to support the strategic business plans of the company. The on-line need date of the facility is usually critical and the time available between recognition of need and the need date is usually less than would be required if engineering, procurement, construction (EPC), and start-up phases were accomplished in sequence. The usual solution is to overlap. The challenge is to do so while still:

- Meeting owner need dates.
- Meeting all owner quality standards.
- Optimizing schedule and cost without compromising other criteria.
- Optimizing human resource utilization.
- Establishing conditions for optimum productivity.
- Facilitating the early detection and forecasting/quantification of potential cost and schedule deviations.

The purpose of this report is to describe a planning and controlling system for the EPC of an industrial project which meets this challenge. An industrial project is utilized as the model due to its complexity, yet most of the principles and techniques described are applicable to other types of construction. Also, this model is idealized based on the philosophies listed below, and as such should be looked upon as an objective. It is understood that the many variables associated with the planning and control of construction may force some deviation.

The system to be described is based on these philosophies and conditions:

- The starting point for planning is the owner's need date for the facility. Planning proceeds in reverse order fashion from this key milestone date and is not complete until all phases have been adequately addressed.
- Scope can be adequately defined early in the project.
- A control base estimate and schedule can be established early in the project.

- Detailed engineering work packages required for field construction must be configured to satisfy the contracting strategy, and be of a completeness and quality that could permit construction to be handled on a multiple, fixed-price contract basis (although other contract forms may be employed).
- Procurement activity must be planned to satisfy both engineering and construction need dates; engineering activity must be planned to satisfy both procurement and construction need dates.
- A team atmosphere must be established among project participants to assure complete and effective communication and coordination over the project's life.
- A computerized control system which effectively integrates or interrelates the many component project functions and provides the managers with timely information needed for forecasting and responsive control must be available and used.

In presenting this system, EPC project phases and their included activities will be described first. Next, the details of the overall control structure will be presented. Finally, the control methods appropriate for each phase will be derived.

PHASES AND THEIR CHARACTERISTICS

The Phases of EPC

The life cycle of an industrial facility encompasses the total time between identification of a requirement for the facility through its final demobilization. This report is concerned with that portion of the life cycle between the time an authorization is given to proceed with engineering until the facility is complete and operational. Within this time period are five phases:

- Conceptual Engineering
- Detailed Engineering
- Procurement
- Construction
- Start-Up

As stated previously, the usual choice is to overlap these phases to bring a facility on line as quickly as possible to meet a market need. Overlapping also reduces the time-value-of-money costs associated with investments that are not yet productive. Figure 1 is a representation of this project format.

To emphasize a point made throughout this report: *planning starts with the need date for the facility and proceeds in reverse order from that date.* The schedule requirements for each phase are roughed out between that date and the proposed start of conceptual engineering essentially as depicted on Figure 1. Then, given these schedule parameters, detailed planning within each phase can begin and the schedule refined.

Characteristics of the Conceptual Engineering Phase

In this phase, the basic functional characteristics of the project are described in terms of input, throughput, output, major components required to achieve those terms, and their interrelationships.

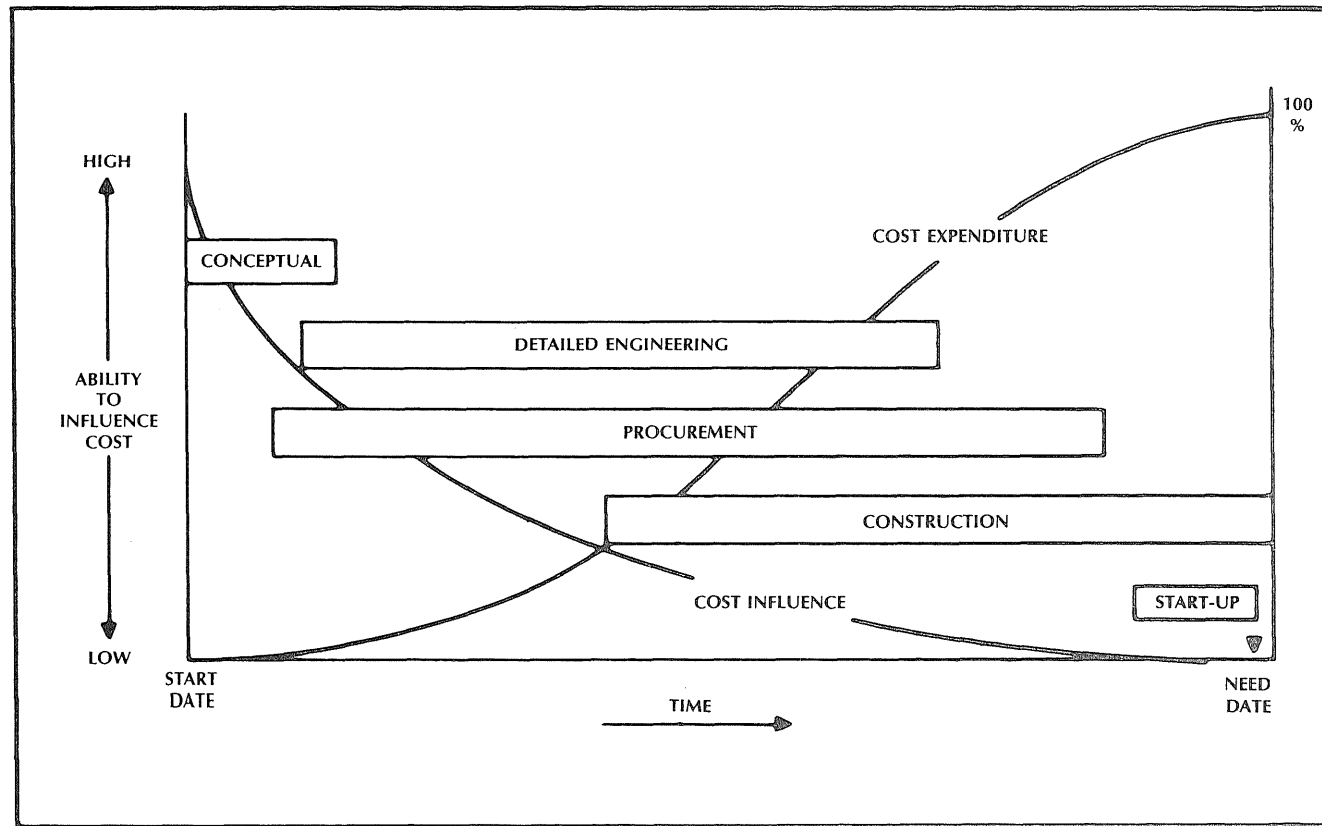


Figure 1. Ability To Influence Final Cost Over Project Life

A major objective of this phase is to achieve a firm definition of project scope to minimize changes during detailed engineering. As illustrated in Figure 1, the ability to control final cost is greatest in the conceptual engineering phase and rapidly diminishes thereafter. Thus, it is essential that adequate attention and resources be applied during this phase to perform the scope definition function.

This phase provides project parameters through:

- Preparation of process flow sheets, heat and material balances, and equipment performance specifications.
- Establishment of operating and maintenance strategy.
- Preparation of studies to select the best concept among available alternatives. Included are value engineering studies (i.e., life cycle economic analysis), constructability analysis, risk analysis, and loss prevention analysis.
- Preparation of mechanical flow diagrams, general design specifications, instrument summary sheets, major equipment specification sheets, preliminary equipment arrangements, preliminary sized-piping line lists, plot plan, electrical one-lines, and special owner instructions.
- Establishment of the execution strategy via a Project Execution Plan that describes the basic organization and responsibilities of project team members, establishes contracting method(s) to be employed, evaluates the labor market, examines potential problems and contingency options, describes risk allocation philosophy, and establishes general timing.

The drawings and other documents developed in this phase are screened to identify special equipment and material items that will be required for the project. Also, the approximate quantity for each item is identified. Lead time for each of these items is established so that the latest date for the start of its procurement action can be determined. Procurement must be initiated for any items that have a start date during this phase, those with complexity that makes them a high risk, or those which require development and have a major impact on detailed engineering.

If licensing or permits are required and have not already been obtained, plans for obtaining these are formulated during this phase and actions initiated to obtain them. Applications for certain permits, particularly those involving environmental issues, can attract the attention of activist groups with the result that approval becomes delayed or denied. For some projects, the owner will not get deeply involved in conceptual engineering